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SOIL CONSERVATION

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SOME ASPECTS OF RESEARCH IN THE SOIL CONSERVATION SERVICE

By W. C. Lowdermilk

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Dr. Lowdermilk.

Research by the Soil Conservation Service in erosion and its control is authorized by the Soil Conservation Act (Public, No. 46, 74th Cong.), and by the Secretary of Agriculture's memorandum of March 27, 1935. In the meaning of this act, wherein Congress recognizes that wastage of soil and moisture resources by soil erosion is a menace to the national welfare and that it is the policy of Congress from now on to provide permanently for the prevention and control of soil erosion and further, wherein Congress has authorized the action taken by the Secretary of Agriculture to coordinate agencies within the Department of Agriculture to effect the purposes of this act, the Soil Conservation Service has a mandate to undertake a program of comprehensive research into the "character of erosion and needs for its control." In approaching such a task, soil erosion control is considered on a long-time basis as a constructive measure in national economy.

The character of erosion implies first, the erosional processes which have been in operation for thousands of years under prevailing climatic controls, land uplift

and under the restraint and interaction of a coverage of natural vegetation. There have developed for each physiographic and climatic region definite responses to the forces of soil formation and land plantation which have resulted in the form of landscape and in the formation of soil profiles. The rate of erosion by wind and water under undisturbed conditions represents a geologic norm of erosion, and would furnish, when discovered, a base line of natural process from which would be measured the degree of acceleration of erosion as a result of agricultural occupation with herds and by the cultivation of fields. This geologic norm of erosion varies from region to region and marks the limit of effectiveness of possible erosion control measures. The law of diminishing returns furthermore may make it economically impractical to reduce soil erosion under land cultivation to this geologic norm.

The needs for the control of erosion can best be set forth by considering the present and future requirements of the Nation and the rate of wastage of soils under present forms and practices.

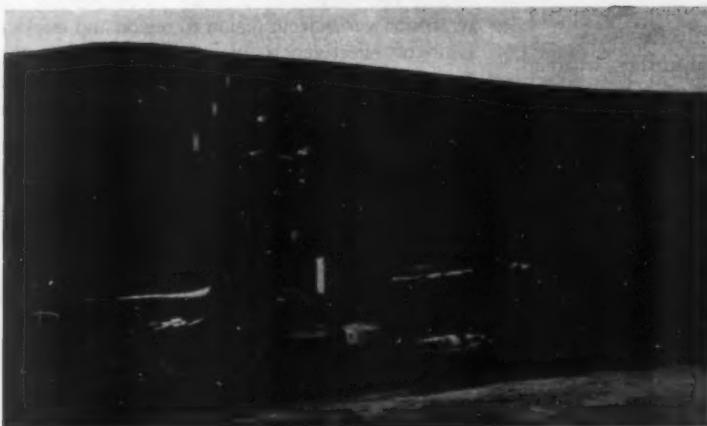
The Continental United States is the homestead of the American people. No new continents await discovery, exploration, and occupation. The fact must be faced that the American people will derive its essential sustenance from this land area now and in the



A shallow, flat-bottomed terrace outlet ditch protected by spreader boards and bluegrass, on the experiment station near Bethany, Mo.



A series of run-off and soil-loss measuring units, located along terraces of experiment station near Clarinda, Iowa.



A series of run-off and soil-loss measuring units located on an exceptionally steep slope of the soil erosion experiment station, at Pullman, Wash.

future. When on November 26, 1934, by Executive order, the remaining public domain was withdrawn from further homestead entry, an era in American history was brought to a close, an era of land occupation. The good lands of the Nation are settled, and the best lands have for the most part been cleared and cultivated. Accordingly, it is fitting that we take stock of this occupation, and its effect on our land resources.

A Useful Survey

The erosion reconnaissance carried out by the Soil Conservation Service in 1934 was such a stock-taking. The results of this survey are known. Suffice it, to call attention to the fact that within the past century the American people have engaged in a huge operation in soil mining. This exploitation which has been common in the past to agricultural occupation in other lands has resulted in soil wastage and depletion on an enormous scale in the United States. An area fully the size of Kansas has been ruined for further cultivation by the riddling, incising and excavating work of gully erosion. Still more portentous is the truncation of soil profiles by sheet erosion, whereby more than one-half of the topsoil has been washed from more than 125,000,000 sloping acres of good land. And wind erosion has made useless for cultivation nearly 10,000,000 acres.

Only about 75,000,000 acres are level or approximately so, on which the water erosion hazard is low. But fully 365,000,000 cultivated acres within humid to semi-humid climates are required to supply the food and fiber requirements of the American people. The major agricultural production of the country must therefore be had from sloping lands, all of which are susceptible to wastage from water erosion, unless adequate measures and practices are followed to reduce, control, and prevent soil erosion.

Research Essential

So rapid is this wastage of soil resources that the trial and error method of long experience is altogether too slow to meet the urgent needs for the development and practice of erosion control measures. Only by systematic investigations, experimental studies, planned and operated in accordance with the principles of scientific research, will measures be discovered and tested promptly enough to save enormous values in agricultural lands. In few enterprises is research more

necessary or more urgent. Increasing population and rising standards of living make more imperative these demands upon production capacities of soils.

Erosion by water action is a geologic process of long standing; it is older than sedimentary rocks, is as old as the first rainstorm. Landscapes have been sculptured under the protecting influence of natural mantles of vegetation, except, of course, in desert areas. Despite this geologic norm of erosion, soils have accumulated in valleys and on slopes under dependent coverages of vegetation. Such norms of erosion have not generally proceeded at rates in excess of soil formation—a most important fact.

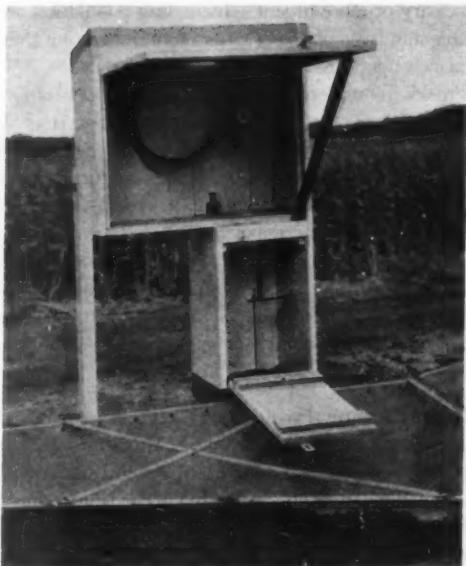
Destructive Process

When the natural mantles of vegetation are removed, or cleared as by heavy grazing or cultivation, soil surfaces are exposed to the full force of wind and flowing water. Erosion of an accelerated order is introduced. This man-induced or accelerated erosion has been found by quantitative measurement to exceed on sloping lands rates of soil formation—a sure process of soil destruction.

Agricultural practices inducing such acceleration of erosion are nothing short of self-destructive; they are suicidal, as extensive areas of devastation and barrenness in once-flourishing regions proclaim to the observer. Crops must be grown, whether or no the methods employed safeguard the soil resource. We can be provident only when in possession of a certain abundance of resources. For a starving farmer will eat his seed grain. Problems of sustained productivity are thus forced upon the Nation by the headlong rate of erosional wastage.

Debris Creates Problems

Along with wastage of the soil itself go other problems arising from soil erosion. Debris is washed off sloping fields and excavated out of yawning gullies to be sorted by flowing water into clays and fine silts which are carried into streams and finally into the ocean or land-locked basins, and into coarser material and sands which are lodged on the way in drainage channels. These accumulations and deposits occur as overwash on fertile fine-textured bottom lands, as shoals in streams and silt deposits in artificial reservoirs. Erosional debris thus impairs the utility of water resources, for navigation and for municipal power and irrigation supplies. And still further, the



Close-up of instrument shelter house, water-level recorder and flume, as installed on soil erosion experiment station at Hays, Kans.

conditions of reduced absorption of precipitation waters and rapid accumulation of surficial run-off into runnels, streamlets and "gully washers" increases the rate and amount of storm run-off and thereby accentuates flood peaks and damage. Such flows discharging into stream channels whose cross-sections are reduced by shoaling of erosional debris, more frequently overtop and spread beyond stream banks as floods.

Wind Takes Toll

Wind erosion, evidenced by spectacular dust storms, although causing damage to large areas of the Great Plains region, is neither as general nor as serious a national problem as water erosion. Yet, in the western

Great Plains it confronts agriculture as a menace to continued productivity of extensively populated regions. Wind erosion of bared plains soils during drought years, sorts the soil much as does water erosion. The fine and fertile particles are carried aloft in dust storms and swept far beyond the area of origin. Coarser particles are left behind to form hummocks, incipient and permanent sand dunes. Extensive areas are thus seriously depleted in value and productivity.

Adequate solutions to such problems of sustained utility of the land, involving a wide variety of interacting factors, must rest upon thorough diagnoses of situations, region by region, and upon an evaluation of component factors. Farming experience has developed, under some circumstances, safeguards in soil conservation. Yet the land generally is exposed to increasing wastage for want of adequate measures or general application. At best the solutions when conditioned by physical, biological, and economic laws, call for a well-grounded program of scientific studies in which past practices will be tested, adapted, and confirmed, as well as the development of new measures.

Many-Sided Program

Such a program includes analyses of the factors of climate, soil formation, plant succession, disposal of supplies of precipitation water by evaporation, infiltration, transpiration, subsurface drainage, surficial flow, and stream discharge under agricultural practices. Then follows the isolation of variable factors through a well-planned series of experimentation capable of mathematical analysis. As variable factors are measured one by one, practicable measures take form in a progressively perfected hypothesis, until finally the hypothesis agrees with experimental findings.

Applicability and feasibility of indicated measures must further rest upon a series of experimental studies



Panoramic view showing young oats and clover, experiment station near Claymada, Iowa.

in measures of erosion control and prevention under different conditions of cropping and cultivation. Limits of safe gradients for clean-tilled crops will be established region by region, for soil series and types, and for characteristics of precipitation in seasonal distribution, amounts, and intensities. Areas of safe cultivation against wind erosion will be delineated by soil types under conditions of periodic dry seasons and prevailing seasonal high winds. Rotations and alternations of clean-tilled and close-growing crops, which conserve soils and water, will be confirmed or discovered. Improvements in the absorption of water in rate and quantity by soils will be discovered in soil management practices, usually in conjunction with improved fertility and productivity. Measures of improved water conservation and control will be established and developed. Agricultural practices, and soil management measures contributing to safeguarding water resources for municipal supply, power, and irrigation will be indicated. All such findings would contribute to the achievement of the objective of the Soil Conservation Act and the policy of Congress—“* * * to preserve natural resources, control floods, prevent impairment of reservoirs, and maintain the navigability of rivers and harbors, protect public health, public lands and relieve unemployment * * *”

Provisional Plan of Study

The achievement of these objectives, within a reasonable length of time, as set up by the National Resources Board, in its report of 1934, namely, within 10 years on seriously eroding areas and within a generation throughout the agricultural areas of the Nation, requires that studies be carried forward in accord with a national program of erosion prevention and control research. Such a program cannot be formulated immediately; it will require full collaboration of authorities of State, Federal, and endowed institutions in soils, agronomy, agricultural engineering, woodland management, human geography, and related fields. Fully a year, and possibly a longer time, will be required for the formulation of the general program, which is to be correlated with investigations of other departmental bureaus. Steps are being taken toward preparation of a provisional program which will be submitted to competent agencies for review and constructive criticism.

Responsibility for the research activities of the Soil Conservation Service are lodged in the Division of Research, for the present under the direction of the Asso-

ciate Chief of the Service. The work of the division has been broken down into five major phases to facilitate direction and supervision, and to secure the best results from the special training and capacities of the research staff.

These phases are the following:

1. Climatic and physiographic studies.
2. Erosion control investigations.
3. Sedimentation and hydraulic investigations.
4. Watershed and hydrologic studies.
5. Economics of erosion and its control (cooperating with Bureau of Agricultural Economics).

Four Lines of Attack

1. Climatic and physiographic studies follow the general recommendations of the Science Advisory Board appointed by the President from the National Research Council. Under this section four general lines of attack are undertaken. They are:

- (a) Climatic investigations and analysis will be planned to determine the general role of climate in its various manifestations on the processes initiating soil erosion.
- (b) Ecological research includes studies of the role of natural or artificially established plant communities and their migration and succession in the problem of soil erosion and its control.
- (c) Geomorphological research includes studies of the complexes of land forms and processes of denudation and erosion, as a geologic process, which bring about regional differences in soil wastage.
- (d) Studies in erosion history include the reconstruction from historical records of the original condition of landscapes prior to intensive agricultural occupation, as a means of evaluating the trends in past agricultural land use, and the possible future trends in land use as conditioned by induced erosion.

Experiment Stations

2. Erosion control investigations are centered chiefly in the system of regional experiment stations for agricultural lands, which were established beginning in 1929 by H. H. Bennett in the Bureau of Chemistry and Soils and transferred to the Soil Conservation Service in April 1935. These investigations include four major phases:

- (a) Nature and degree of erosion as conditioned by slope gradient, slope length, soil series and types, distribution and intensities of precipitation, condition



Terraces with light covering of snow, on soil erosion station near Clarinda, Iowa.

of soil coverage of various crops and combinations of rotations, and the physical and biological factors influencing erosion and loss of precipitation waters by surficial run-off. Such studies are generally carried out on experimental plots and fields and in lysimeters. This information is being established at 13 existing erosion experiment stations for a number of representative agricultural regions of the United States.

(b) Methods and measures of erosion prevention and control on agricultural pasture and woodland areas, as effected by suitable and adaptable agronomic rotations of crop combinations, measures of increasing organic content of soils and their favorable structure, cultural practices on contours, and strip cropping, broad-base terraces, bench terracing by means of permanent strip

cropping, by measures of gully control such as check dams and revegetation, by measures of spreading flood waters in the alluvial plains of the west, and related methods.

(c) Rebuilding of soils depleted by erosion. Only a beginning has thus far been made in this phase of agriculture. Such measures when developed and applied will restore productivity on large areas of formerly good lands now generally stripped of topsoils by sheet erosion.

(d) Reclamation to useful crops of pasture and forests of areas ruined for further cultivation by gully erosion.

Sedimentation Studies

3. Sedimentation and hydraulic studies will establish information and carry forward studies of the processes and rates of erosion-debris transportation and deposit. Such investigations are grouped under—

(a) A Nation-wide investigation of storage reservoirs to provide an accurate record of reservoir sedimentation and rate of storage depletion as it affects utility and longevity of water supplies. This work involves reconnaissance examination and report on all important reservoirs in the country. Detailed reservoir studies will establish information on factors involved in silting, rates of silting as related to different slope, soil, and climatic conditions, to be correlated through other sections of research and agencies with land-use and erosion-control practices in tributary drainage areas.



Men taking samples of flow through divisor box and weir, to obtain correction factor; silt-sampler below unterraced area. Silt box is 40 feet long, 3½ feet deep at weir, and constructed out of contact with soil. Statesville, N. C.

(b) Investigations will be made of conditions and processes of sedimentation in minor stream channels and valleys, resulting from accelerated erosion of tributary upland areas.

(c) Hydraulic laboratory investigations will include studies of factors affecting the energetics of debris-laden water, the wear of debris in course of stream transportation, specific field-construction problems, development of new erosion and flowage-control practices, and experimental application of results to full-scale engineering problems of gully and arroyo control in the field. This work includes the development of new special-purpose measuring and sampling apparatus and field surveys of prototype conditions that present the problems to be investigated by model experimentation in the laboratory.

(d) Factors of bed-load transportation in natural streams will be studied by direct measurement with new type installations to be placed at selected sites on tributary streams in different type regions of the country.

Watershed Studies

4. Watershed and hydrologic studies will be centered in a series of experimental watershed areas where the objectives are—

(a) To determine the effect of land-use and erosion-control practices on the conservation of water for crops and water supply and upon the control of floods upon conditions prevailing in typical agricultural regions. Ten such studies are contemplated.

(b) To determine the effect of land use and erosion control practices for small and large areas and to trace variations in this effect from plots through a series of intermediate watersheds to the largest watershed of the experimental area.

(c) To determine the rates and amounts of run-off and eroded material for precipitation of different amounts and intensities for typical watersheds, of different configuration, size, shape, topography, cover, underground conditions, land-use, and erosion control practices. To furnish data needed for the design of erosion control structures.

Economic Aspects

5. Consequences of unrestrained erosion and of measures of erosion control, as reflected in the economic status of farming operations on farms within project areas, will become the object of studies in cooperation

HOLIDAY GREETINGS

To every member of the Soil Conservation Service I extend my sincere wishes for a very Merry Christmas and a Happy New Year.

This is the season when we may well lift our heads a moment from our absorption in maps, contracts, research, and demonstrations, and give a smile and a greeting to a neighbor.

May Christmastide be bounteous in its blessings to you, and may the New Year be fruitful in its realizations.

W. H. Bennett.

with the Bureau of Agricultural Economics. The purpose of these studies is to furnish the basis of comparison of the economic as well as social conditions on demonstration projects, at the inception of the program of erosion control and at the end of the 5-year period covering cooperative agreements with farmers.

These are some of the major outlines of investigations to be conducted by the Division of Research of the Soil Conservation Service to furnish a factual basis for the planning and conduct of erosion control operations and in their progressive refinement in keeping with the adaptabilities of land, with the requirements of safe land use, and with adjustments to economic demands and considerations.

Division of Research

Direction of research is provided for as follows:
Chief of division (Acting), W. C. Lowdermilk.

Sections

1. Climatic and Physiographic Studies, Dr. C. W. Thornthwaite, head of section.
2. Soil Erosion Control Investigations, Dr. R. V. Allison, head of section.
3. Sedimentation and Hydraulic Investigations, H. M. Eakin, C. E., head of section.
4. Watershed and Hydrologic Studies, C. E. Ramser, C. E., head of section.
5. Economics of Erosion and Erosion Control, Dr. Walter Roth, liaison officer with Bureau of Agricultural Economics, and head of section.

EVALUATING EFFECTS OF SOIL TYPE, SLOPE, AND EROSION ON PRODUCTIVITY

By A. H. Paschall and E. H. Reed

The soils and erosion-control practices divisions of the Salt Creek watershed project, Ohio, have devised a system which gives proper weight to soil type, slope, and erosion as factors in crop production.

How the System Works

The system has as its basis the productivity indices of the different soils for various crops as listed in Special Circular No. 44 of the Ohio Agricultural Experiment Station. These index numbers, ranging from 1 to 10, represent the factor of soil in its normal condition on the slope characteristic of that soil. It is possible to introduce the slope and erosion factors and to make compensation for them by applying a percentage differential in the productivity number according to the sum total of the relative effects of slope and erosion on the yields. Field observations have shown that under similar conditions of soil and slope different degrees of erosion show variations in yields. The relation of these variations to degree of erosion represents the effect of the erosion factor. In like manner, the reduction of yields due to slope conditions may be obtained. The total of these percentages for slope and erosion is determined and subtracted from 100. This figure multiplied by the productivity index gives an index number which has been compensated for soil, slope, and erosion factors.

The accompanying table gives this final percentage of reduction as worked out for the sandstone and shale soils in the Salt Creek watershed. In preparing these tables, it was found possible to classify the soils into three general groups: (1) Sandstone and shale, (2) limestone, sandstone, and shale; (3) deep soils. On soils where there are no erosion and slope factors, such as flood plains, 100 percent of the productivity index is used.

"Among other things which have been brought about by the depression is the more honest consideration for the conservation of our natural resources. Especially is the conservation of soils, wild animals, and plants receiving considerable attention."—Montgomery Herald, Troy, N. C.

PERCENTAGE PRODUCTIVITY FOR DIFFERENT SLOPES AND DEGREES OF EROSION ON SANDSTONE AND SHALE SOILS

Erosion classes	Slope classes ¹			
	A	B	BB	C and D
1	105	100	90	70
2	105	100	85	50
27	95	95	80	45
3	80	75	65	30
37	75	70	60	25
38	35	30	25	15
4	55	50	40	15
47	50	45	35	10
48	30	25	20	0

¹ Slope percentage:

A—0-5.

B—5-12.

BB—12-20.

C and D—over 20.

Erosion class:

1—No apparent erosion.

2—0-25 percent surface soil lost.

3—25-75 percent surface soil lost.

4—75 percent plus surface soil lost.

5—Occasional gullies.

8—Severe gullies.

To obtain the index number for the crop land of an entire farm, proceed as follows:

1. Average the productivity index numbers for the crops of each soil type.
2. Derive a corrected index number by the use of the table.
3. Multiply the corrected index number by the total number of acres of each soil type on the farm.
4. Total the products of step 3.
5. Divide this total by the total number of acres.

The quotient will be the compensated productivity index number for the crop land on that farm.

This index number represents the production to be expected from the land under prevailing conditions. Should actual yields run higher than productivity indexes, they will constitute a tribute to farm management.

While this method of calculation is imperfect and not to be relied upon for accuracy, it does recognize the reduction in yields effected by erosion and it gives impetus to a study from which much may be expected in the future.



August Jungemann explaining his crop rotation and strip-farming to agricultural field men of a farm real-estate association

VISITORS SEE FARMS RESTORED WHEN EROSION IS CONTROLLED

By I. N. Chapman

Erosion-control demonstrations in the Shue Creek-Wolsey areas, Beadle County, S. Dak., have recently been the object of a number of organized inspection tours.

Two groups of field men of the Federal Land Bank of Omaha, 43 agricultural supervisors of insurance companies, and officials of railroads serving the territory were among those visiting the projects.

The trips were made on days convenient to the interested parties, and included land not under cooperative agreement, as well as land where erosion-preventive methods are in use.

Of Educational Value

These tours proved of great educational value. A statement by W. M. Willy, field man for the Federal Land Bank of Omaha, reflects the deep impression made and is typical of a number of interesting letters received as a result of similar inspection trips. Part of it reads as follows:

That first stop on the Karnstrum 480-acre farm gave one a depressed feeling, to stand in that once beautiful farmyard and see the huge drifts of topsoil piled like banks of driven snow around the excellent farm buildings. The buildings must have cost \$15,000, and are now surrounded by hundreds of acres of barren fields.

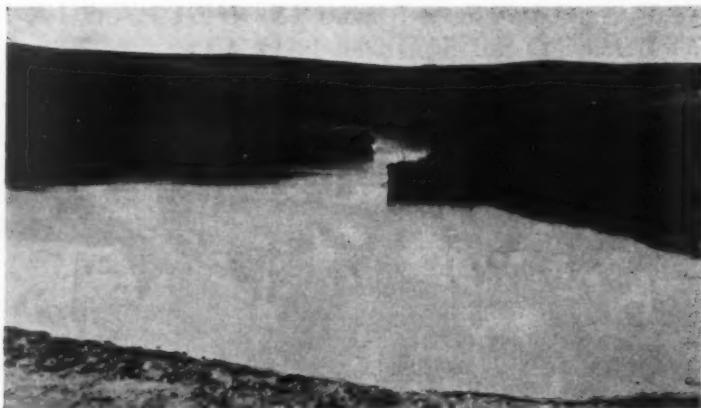
The slight breeze stirred the silty sand, and blew it into our eyes. On a real windy day you couldn't have faced it. The main road was blockaded by a breast-high drift a half-mile long. The drift completely filled the section line from fence to fence. Uncovered posts here and there were bright with a sand polish from numerous storms. The devastation of this once rich and profitably productive farm land reminded one of a ghastly, deserted battlefield.

Life-destroying forces had been turned loose to annihilate nature's countless centuries of constructive effort, and the pioneering work of two generations of earnest farmers.

A Picture of Desolation

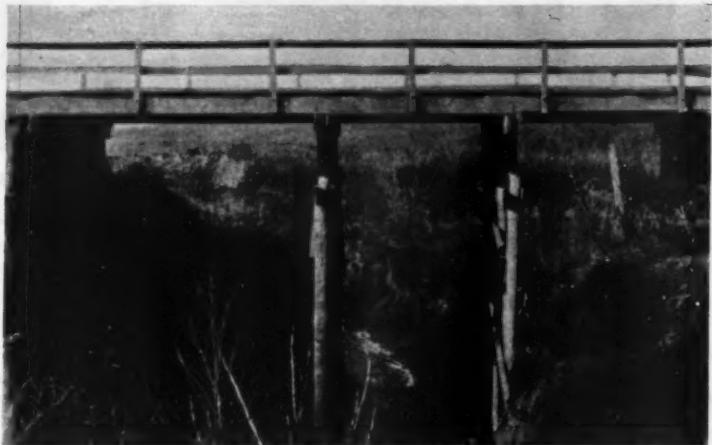
The picture of warlike wastefulness was made even more vivid when we entered the deserted farmyard of the Giester homestead. Windows were broken, doors blown open, barn roof sagging down, barn walls caving in, fences drifted over, and a splendid flowing well running wild over a yard filled with dust hummocks which were scattered about like banks of earth churned by heavy artillery.

[Continued on page 11]



Taken from center of dam, this picture shows drainage area above and pond formed from melting snow. The water extends nearly 1,000 feet up the gully.

A look into the 22-foot gully, which shows the patch-work job on the bridge pilings. Cooperative effort will be aimed at checking erosion permanently. A large earth fill is included in the plan. Drainage water will be handled by installation of a concrete spillway.



A view of the 6,000-cubic-yard fill and 8-foot box spillway. Trees and grass have been planted on the downstream side of the fill.

HIGHWAY PROTECTION IN NEBRASKA

(Pictures on opposite page)

During the winter of 1934-35, the Soil Conservation Service in Nebraska instituted a program of erosion control in connection with highway structures and the elimination of serious gullying of adjacent farm land.

On one highway in Nance County was a 22-foot gully, spanned by a 42-foot wooden bridge. This was the third structure of its kind that had been constructed over this gully in the last 10 years. Each structure had to be larger and more expensive than its predecessor. Replacement of this particular wooden bridge would have cost the county commissioners of Nance County \$2,500. The present bridge was becoming undermined and unsafe, due to undercutting. It called for immediate removal and replacement by a larger and more expensive structure.

Soil Conservation Service engineers undertook a cooperative arrangement whereby the county would furnish the materials, the F. E. R. A. would furnish the labor, and the Soil Conservation Service furnish the technical supervision and design for a permanent structure that would forever eliminate the bridge and at the same time stabilize the erosion on the upstream side of the gully, which was over a mile long. The wooden bridge was removed and an earth fill made, which formed the highway grade.

An 8-foot concrete box culvert was constructed with an inclined spillway on the downstream side.

Today the gully, which was formerly impassable has silted almost to capacity. The highway grade remains intact, and the concrete culvert and spillway has been successful.

Approximately 25 similar structures have been built in the Plum Creek drainage area. The technical layout was supervised by engineers of the Service. Actual construction has, in most cases, been done by F. E. R. A. labor and, in many cases, private land-owners have put up the money, or a portion of it, for the materials needed.

A recent understanding has been entered into with the commissioners of Boone and Nance Counties, under which technical assistance will be furnished by the Service in the design of all bridges and culverts on highways in the Plum Creek drainage area. Further agreements have been entered into with the county commissioners which will permit the Service to use W. P. A. labor as far as authorized in connection with the construction of these bridges and culverts when weather conditions do not permit erosion control operations in the field.

This is a field of cooperation which offers a practical solution toward the conservation of agricultural lands and the elimination of an enormous expenditure of public funds.

VISITORS SEE FARMS

(Continued from page 9)

The family had been driven away by the many attacks of drifting soil. Their neighbors had been separated and scattered to the ends of the earth—14 families in the immediate community were forced to desert their comfortable homes because of this awful warfare of the savage and relentless wind.

One could not help asking, "Isn't there some way to stop this deadly destruction of soil and humanity?"

But the Jungemann place was a revelation to me! The last time I had paid careful attention to this farm was in the early spring of this year.

It was on a windy day. I stood between the Jungemann house and the barn. I could scarcely see either. The clouds of swirling dust enveloped me like a raging black blizzard. It pained the lungs to breathe. The surrounding fields were a veritable desert. All it needed to make the comparison more realistic was a few camels standing in the lee of a dust bank—and it required very little imagination to see them.

On the day of our project visit all that was changed. The drifted dirt had been removed from around the buildings, from the fences, from the trees, and from the highway. The horse-high hummocks in the fields were leveled down. Alternating rows of corn and small grain, planted in diagonal stripes at right angles to the prevailing winds, had taken complete possession of the fields. A healthy growth of sweet clover was already at work restoring the wasted vital elements of the topsoil.

The neat appearance of the farmyard gave ample evidence that the good, thrifty German farmer who lives here had again taken heart. He had been encouraged to stick it out. He was continuing his fight to maintain his family and to save his home—a home which he himself had wrested from the wilderness nearly 50 years ago.

The forces of engineering, of agronomy, of forestry, of farm management, of education, and of inspiration which you have marshalled on the Jungemann farm point the way to rehabilitation of drifting wind-blown areas. The results already accomplished here by the Soil Conservation Service conclusively prove that wind-damaged areas can be controlled, and better yet, restored to usefulness under their present owners.

MACHINERY THAT FACILITATES THE HARVESTING OF GRASS SEED

By Guy C. Fuller

One of the problems connected with the reestablishment of native sod in dust-blown regions concerns itself with the harvesting of seed.

Grass nurseries have been set up by the Soil Conservation Service, therefore, to collect native grass seed for the reseeding of large areas of abandoned land; to encourage reseeding and improvement of those areas that are approaching abandonment; to increase and encourage the use of valuable species never before introduced; to discover the best cultural methods and encourage proper management of vegetation.

At the moment we are focussing attention on the lands west of the ninety-eighth meridian—a significant line of demarcation because it is here that grasses divide into groups, with the tall ones to the east and the short ones to the west.

Conferred on Program

Last May a number of regional nurserymen, agronomists, and State cooperators attended a meeting in Colorado Springs to formulate a program for the work west of the ninety-eighth meridian.

They gave attention to the factors involved in establishing meadows with one or all of our native grasses. Extreme care is required in harvesting the seed, in application of methods of seeding, in date and rate of seedings and in seed mixtures.

In general, the harvesting of this native seed can be done with the present machinery. The wheat grasses and many other tall grasses can be harvested with ordinary farm machinery, but some of our short grasses present a more difficult problem.

Many species occur in waste places along railroad banks, roadsides, fence corners, and rugged hilltops, making the use of harvesting machinery impracticable. Seed collecting in such places is done by hand. The tops are cut with sickles or large knives and put into bags thrown over the shoulder. These tops are dried and later threshed and cleaned.

Hand Stripper Developed

Seed gathering in such places has been greatly facilitated by a hand stripper devised by Gerald Mott, a Government employee at Stillwater, Okla. This

device derives its power from a two-cylinder washing-machine engine. The dimensions of the cylinder are 40 inches by 14 inches. It operates at 700 revolutions per minute. The hopper is of sheet metal mounted on an eccentric frame supported by two automobile wheels on pneumatic tires. The eccentric frame allows for height adjustment. The use of such a machine is limited but it serves the purpose for which it was designed.

One of the most economically valuable grasses is Blue grama (*Bouteloua gracilis*) which is widely adapted to the Great Plains area and is recognized as one of the most valuable species for erosion control. This being a short grass, the use of the combine is not possible, and to mow, rake, or thresh the crop would not be feasible because too much seed would be lost in handling; therefore, grass strippers were used for harvesting this crop, and they worked satisfactorily wherever large machines could be operated.

A Horse-Drawn Type

A horse-drawn stripper—another recent development—will cover from 6 to 7 acres a day, requiring one man and a team to operate. The cylinder in this case is a hollow drum made of wooden slats filled with staggered rows of spikes. The speed of this cylinder is also about 700 revolutions per minute. Height adjustment ranges from 6 inches to 14 inches.

Short cuts and labor-saving devices are always worth considering, on any job, so to speed up the work with these machines the long tongue used with a team was replaced with a short one and three machines were hooked in tandem and pulled with a tractor. Thus arranged, the strippers will cover from 25 to 30 acres a day, one additional man being required.

In this way costs are reduced and a larger acreage is covered in a given time. The importance of this may be emphasized by the fact that under certain conditions ripe seed is shattered within a few days.

Such machines as these are very limited in usefulness because of the height adjustment. The ideal stripper for harvesting native grasses is economical, able to cover from 25 to 40 acres per day, is adjustable to grasses ranging from 6 inches to 4 inches in height and is simple to operate.

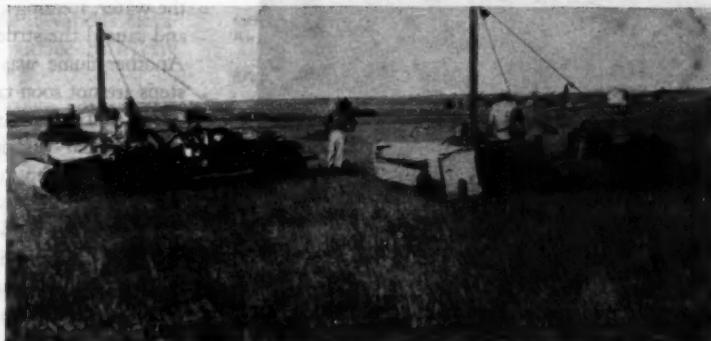
A power stripper, the first machine of its kind, was built at Oshkosh, Nebr., and, although not perfect, it approaches our objective.

Following is a comparison of this stripper with a horse-drawn stripper:

Tractor-drawn:	Horse-drawn:
10-foot swath.	6-foot swath.
4-foot range in height.	18-inch range in height.
25 to 35 acres per day.	6 to 7 acres per day.
Transported under own power.	Truck.
One man.	Team.
Gas and oil.	

An old automobile chassis serves as the power unit. The rear axle is thrown over, producing a pull instead of a push effect. The steering gear is attached to the frame over the rear axle with the steering rods lengthened. A cylinder is mounted in one side of the large hopper, just as in the horse-drawn stripper. A bar 10 feet long with 18 inches on each end turned at right angles and fastened near the end of the frame forms a support for the hopper. A steel cable with adjustable clamps extends downward and fastens to the back side of the hopper. A long lever attached in the center produces a lift or height adjustment by eccentric action.

Two of the newly developed power strippers in operation in the west.



A GOOD COVER GRASS

Bermuda grass, says Charlie Acres, who lives near Greenbrier, Ark., helps to control erosion and supplies good grazing on the rolling slopes of his farm. He has used it for pasture a number of years and finds that cattle, mules, and even pigs are fond of it, that even a small area, well sodded, is an asset to a farmer in his section of the country.

On his creek-bottom farm, he has produced Bermuda for hay, having succeeded some seasons in mow-

The cylinder is driven from what is now the front wheel by chains and sprocket wheels. The size of the sprockets determines the speed of the cylinder.

Advantages in favor of the power stripper are:

1. It moves under its own power.
2. It may be transported from one field to another without any adjustment.
3. The height adjustment ranges from 6 inches to 4 feet.
4. It is possible to secure cleaner seed because of the flexibility of the cylinder and hopper. By pulling down on the rope the hopper is raised, allowing it to pass over noxious weeds or any other undesirable materials.
5. This adjustment allows the machine to be operated upon rougher ground and much of our native seed is harvested in fields where machinery has never been used before.
6. It can be operated by one man.

These strippers and our ordinary farm machinery have solved satisfactorily the problem of harvesting most grasses, but leave us another harvesting problem of greater magnitude, which will be discussed in a later article.

ing and saving it when it has not been too closely grazed.

He has noticed that heavy rains the past spring have been disastrous to steep slopes of cultivated fields on farms where there are no vegetative covers and where terraces have not afforded a means of holding run-off till it can percolate. In his own fields, where slopes have been taken for Bermuda grass cover, over-sown to lespedeza, after they have been contour furrowed, erosion has been controlled. For sodding slopes Bermuda has no equal in erosion practice, he believes.

HEAD EROSION AT ITS WORST

A 6-day debacle of an irrigation diversion canal in the Gardena farming district in Washington produced a gully 1,500 feet long, 30 to 120 feet deep, 75 to 120 feet wide—an excavation of approximately 325,000 tons of soil!

The story of this Burlingame irrigation tragedy is as fantastic as it is true.

Built in 1904, the diversion canal 2 miles south of Lowden, Wash., and 14 miles west of Walla Walla,



Overshot flume with which it was hoped to stop head erosion.

served to control the stream flow of the Burlingame irrigation ditch. When the March winds blow each year, tumble weeds whipping along the canal are stopped and piled up by the concrete constriction of the channel at the intake, choking the flow of water. To clean out these accumulated obstructions, the stream flow was temporarily shunted into another diversion canal emptying into Pine Creek a few miles distant.

Started on Small Scale

Until March 1926 a small gully about 10 feet deep and 6 or 8 feet wide was all that marked what was to become a miniature Grand Canyon.

It was then, however, that the winds blew steadily for 6 days and the entire 80-cubic-feet-per-second flow of the main canal, which irrigates 5,000 acres of fertile land, was crowded into the diversion ditch. Under this extraordinary pressure, the stratum of hard underlying material gradually gave way and head erosion began in earnest.

The gully became a gulch: The gulch became a canyon. Below the hard stratum lay an old lake bed deposition of sand and soft, fine clay which allowed the miniature falls to cut deeper and deeper and offered little resistance to the forces of head erosion. In 6 days the gully grew, carrying hourly more than 2,000 tons of soil and removing approximately 4,725,000 cubic feet of earth. The water flowing into Pine Creek was estimated to contain more than 18 percent silt by weight. Thousands of tons of silt were carried into the Columbia by the creek.

Failure of Flumes

The following year, 1927, an overshot flume was built and projected into the mouth of the canyon to prevent further heading. But the combined action of the water, freezing and thawing, loosened the footings and caused the structure to fall to the chasm bottom. Another flume was built, but this, too, will fall if steps are not soon taken to insure its retention.

Due to weather action, the walls of the gully slough off an annual deposit of loose soil which collects from 8 to 10 feet deep in the gully bottom. Each March, when the wind blows, the water is again turned into the chasm and the loose material melts like sugar in a few hours and the sirupy silt rolls on to the Columbia.

At the present time this overgrown gully has widened to an average of nearly 100 feet at the top and has a maximum depth of 120 feet. A recent survey by engineers of the Soil Conservation Service project at Athena, Oreg., found that more than 9,588,000 cubic feet of earth have been removed. It has cut back into a long, sloping ridge standing as an erosion remnant of a once higher land.

Geological Explanation

Prof. B. H. Brown, of Whitman College in Walla Walla, who has made an intensive study of the geologic history of this gorge, reasons that the alternate hori-

A general view of the spectacular gully caused by the overflowing of the Burlingame irrigation ditch.



zontal strata of sand and clay indicate the remains of old lake bed deposition. These sand strata vary from 6 to 14 inches in thickness. Each set of strata, composed of one layer each of clay and sand, represents a flood period. Whether they were annual floods, or caused by rains, melting snow, or ice cannot be determined.

There are many vertical seams of sand and clay as much as a foot wide, which extend from the bottom of the gully upward and terminate at various elevations, but always at the upper surface of a clay stratum.

"These seams", says Professor Brown, "were once large cracks which occurred during the time when the lake became dry." At intervals during a dry period small floods of short duration spread over the lake bed and washed the sand and clay down into these cracks.

Remnants of Granite

Although all rock in this region is of basaltic origin, pieces of granite of various sizes appear at different levels in the clay strata of the gully. These remnants of granite were evidently brought down from the north by glacial ice. As the ice broke up and floated out on this lake and melted, the rocks were precipitated to what was at that time the lake bottom, where they now lie at various depths. Due to the granite which is found at different levels and because the lake appears to have been completely dry at intervals, Professor Brown is led to believe that the forming of these stratifications and the glacial age were coexistent and that the glacial ice came down at several different periods.

Parts of mastodons and other prehistoric animals, including a tooth weighing three and one-half pounds, have been found in the gully. The presence of these historic relics gives the thought that some time had elapsed since this lake was in existence.

Our project engineers have suggested a plan which will control erosion in the gulch. The plan, in brief, calls for the construction of a wooden flume around the gully which will detour the water from the diversion canal to Pine Creek around the present washout. Then the walls of the gully would be broken down and the gully allowed to stabilize itself with vegetation.

Threatens Farmhouse

Large earth cracks are now visible along the rim. Because of the danger involved, Professor Brown has discontinued the practice of taking his geology students to the gully. If not soon controlled, the gully will eventually engulf a farmhouse which lies in the course of its erosion.

A spectacular example of head erosion at its worst, the Burlingame irrigation monstrosity is a destroyer of land, a menace to lives and property, and a source of future expense to the Bonneville Reservoir.

"Soil-erosion control is one step in a program that should be earnestly encouraged throughout the South. It should be accompanied by crop rotation—in fact, it is the big brother of that scheme of diversification which seeks to keep land active, productive, and remunerative."—Tyler (Tex.) Courier-Times.

CHECK DAMS STABILIZE GULLIES



Planting willow cuttings in a gully. With the brush and wire check dams holding active erosion in check until the trees become well established, permanent control is expected.

In the Plum Creek drainage area, Boone and Nance Counties, Nebr., the Soil Conservation Service, using E. C. W. labor, has completed the construction of several thousand temporary brush and wire check dams such as the series shown here.

Above each dam there is a silt deposit of approximately 4 feet in depth, as shown in the picture. This type of structure has stabilized active erosion in the bottom of the gully. C. C. C. boys are engaged in planting willow cuttings in the accumulated silt to establish permanent control.

In a few years many of the deeper gullies will be partially silted in, and erosion permanently stabilized by trees, shrubs, grass, and other vegetation.

Farmers in this area like the idea of producing in these gullies something that will be of economic value. The trees will furnish a source of wood and posts, and afford a protection to wildlife and game, as well as change an unsightly and destructive gully into a timbered spot of beauty and usefulness.

RELIEF LABOR

Exceeding its quota by more than one-third, November 16 reports from all parts of the country indicate gratifying progress in the employment of relief labor by the Soil Conservation Service.

A statistical summary as of this date follows:

Rank	State	Num- ber relief workers	Relief labor quota	Acting State coordinator	Percent of relief labor quota
1	Idaho	222	54	Rockie	411.1
2	New York	982	363	Howe	269.0
3	New Jersey	605	236	Lee	236.4
4	South Carolina	1,380	637	Carnes	216.6
5	West Virginia	356	173	Cutler	205.8
6	Michigan	316	156	Cutler	202.6
7	Ohio	797	402	Cutler	198.3
8	Colorado	1,245	632	McClymonds	197.0
9	Missouri	803	437	Uhlund	183.8
10	Virginia	552	310	Carrier	178.1
11	Maryland	277	156	Bruce	177.6
12	Minnesota	311	178	Davis	174.7
13	Iowa	610	486	Uhlund	125.3
14	Georgia	1,101	653	Rast	168.1
15	Oklahoma	1,260	800	Winters	157.5
16	South Dakota	345	349	Cleamer	136.2
17	Nursary	674	253	Enlow	266.4
18	Kansas	604	390	Doley	134.9
19	California	999	629	Reddick	152.5
20	Indiana	232	156	Cutler	148.7
21	Nebraska	252	172	von Trebra	146.5
22	Wisconsin	293	205	Davis	142.9
23	Illinois	417	294	Fisher	141.8
24	Pennsylvania	598	435	Patrick	137.5
25	North Carolina	1,486	1,110	Stallings	133.9
26	Washington	157	118	Rockie	133.1
27	Texas	1,745	1,342	Merrill	129.9
28	Mississippi	780	620	Anders	125.8
29	Arizona	1,941	1,536	Boyle	124.7
30	New Mexico	1,942	1,569	Calkins	123.7
31	Arkansas	838	730	Sargent	114.8
32	Kentucky	282	257	Alberts	109.7
33	Oregon	176	185	Rockie	95.1
34	Alabama	363	390	Bailey	93.6
35	North Dakota	123	156	Cleamer	76.8
36	Louisiana	470	330	Mims	85.5
37	Wyoming	140	111	McClymonds	45.0
38	Montana	70	156	Aicher	44.9
39	Research	489	1,334	Allison, etc.	36.1
40	Utah	27	136	Calkins	19.9
41	Florida	13	91	Bailey	14.3
42	Maine	0	97	Patrick	0
43	Nevada	0	156	Reddick	0
Total		26,433	49,444	Average	135.9

BURNING CAUSES LOSSES

Burning meadow land is an expensive operation, says C. B. Watkins, Logan County (Okla.) farmer.

An accidental fire burned 45 acres of prairie meadow land on Watkins' farm on August 10, 1934. In 1935, a fair year for hay production, the yield on the meadow was less than half normal and weeds in the hay caused it to be unsalable.

Experiments conducted at the Red Plains Soil Erosion Experiment Station, Guthrie, Okla., prove that Watkins' experience is not at all uncommon. Five-year experiments show that burning multiplies the water loss by 28 and the soil loss by 12.